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CANADIAN PATENT

BRIS N3870W/51 ★CA-978-737

Theodolite system for aligning guns and directors on warship - using electrolytic levels with electrical outputs, and clinometer

BRISTOL AIRCRAFT LTD 20.03.73-CA-166493

R11 (02.12.75) G01b-00/*

(54) A! ...RES

The apparatus comprises two levelling instruments each of which has a sensitive axis and gives an electrical signal which, for a range of attitudes, is a function of the magnitude of the angle between that axis and the direction of the earth's gravitational field at any moment, means for rotating each instrument about an axis which is approximately vertical, a central receiver, and means for transmitting the signals from the instruments to the receiver. The receiver contains means for taking the instantaneous difference of the signals, and means for displaying or recording that difference. The means for rotating each instrument may be secured to the ship or may be located within the theodolite. 20.3.73 as 166493 (13pp).

(70) !

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(30) PRIORITY DATE

No. OF CLAIMS 1

electrical signal which, for a range of attitudes, is a function of the magnitude of the angle between that axis and the direction of the earth's gravitational field at any moment, the method comprising:

(a) installing a first such instrument on the structure, either on a first mounting or on a piece of equipment, with provision for rotation of the instrument relatively to the structure about a rotation axis which is approximately vertical, the sensitive axis being perpendicular to this rotation axis,

(b) likewise installing a second such instrument on said structure on a second mounting or piece of equipment,

(c) bringing the two instruments to rotational positions about their rotation axes each with its sensitive axis approximately aligned with a common direction in the structure, and taking the instantaneous difference of the signals of the two instruments, thereby obtaining an output the magnitude and polarity of which varies in accordance with the magnitude and polarity of the angle between the rotation axes when projected onto the vertical plane containing the common direction,

(d) thereafter rotating each instrument about its respective rotation axis in the same polarity through the same angle, and again taking the instantaneous difference of the signals of the two instruments,

(e) adjusting at least one mounting or piece of equipment, having regard to the differences taken under steps

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not part of the present invention, which includes switches controlled by knobs 30, and a meter visible through a window 32. By operation of the switches, the meter can be connected to be actuated either by a signal from a selected one of the levels, or by the signals from a selected two of the levels, in such a way as to display the instantaneous difference of the signals.

It will be apparent that a suitable type of circuit for taking the instantaneous difference of the signals from two levels such as are shown in Figure 3 is a Wheatstone bridge in which the four limbs are constituted by the left and right halves of two levels.

Two of the levels 12 are mounted on a clinometer. This consists of a base 34 having a flat undersurface 36, and a platform 38 which can be rotated relatively to the base 34 about a horizontal axis, and then locked, the inclination of the platform to the base being indicated by a scale. Such clinometers are well known. The level 12 is fixed on top of the platform, with the sensitive axis of the level (i.e. the direction of length of the enclosure 18) extending in a plane perpendicular to the axis of rotation of the platform 38 relative to the base 34.

The other two levels 12 are mounted on respective theodites. These are shown diagrammatically in Figure 1, and one is shown in more detail in Figure 2 to which reference is now made.

As is well known, a theodolite includes an upper body 40 that is rotatable relatively to a lower body 42 about a substantially vertical axis. This lower body is supported by levelling screws 44 on a base 46 which is mounted on a tripod 48.

A telescope 50 is carried by the upper body 40 on a horizontal axis 52, about which the telescope can be rotated to elevate and depress the telescope.

these readings are all the result of taking differences between the signals from the two levels, they are not affected by bodily motion of the ship (this is assuming that the motion is not so violent as to introduce substantial accelerations, nor so extensive as to cause the levels to operate beyond the range at which there is a linear relationship between tilt and signal).

It is possible that the ship may have an angle of list such that the levels, if placed directly on the surfaces, would reach the end of their available range. Since the levels are mounted on clinometers, if such a situation develops, then both clinometers can be inclined to an equal extent, with no effect on the difference readings recorded from the receiver.

With previous procedures, using bubble levels observed visually, it has been necessary to fix the ship in a particular attitude by shoring up in a dock, With the use of the present invention, the ship can be fully afloat, and even at sea in reasonably calm water, and it is also possible for loading to be in progress, so that the trim of the ship is changing.

Example 2

The two levels mounted on theodolites are used to determine the relative alignment of a piece of equipment and its datum, where the datum is not in direct sight of the piece of equipment.

For this purpose, one theodolite is stood in a convenient position in view of the datum, and the other theodolite is stood in a convenient position in view of the piece of equipment. Then, by the use of the present invention, the two theodolites are aligned with one another. This is described below. Once this alignment has been achieved, then information is obtained optically, by methods which are no part of the present invention, as to the relative alignment of the first theodolite and the datum on the one hand and of the second theodolite and the piece of equipment on the other hand.

Usually the datum and the piece of equipment already have

(e) adjusting at least one mounting or piece of equipment, having regard to the differences taken under steps (c) and (d), so as to bring the rotation axes into exact parallelism,

(f) tilting the structure about a horizontal axis into an inclined attitude such that the rotation axes are substantially out of the vertical,

(g) taking the instantaneous difference of the signals of the two instruments while the structure is in this inclined attitude, and

(h) rotating one of the instruments about its rotation axis until the difference is zero.

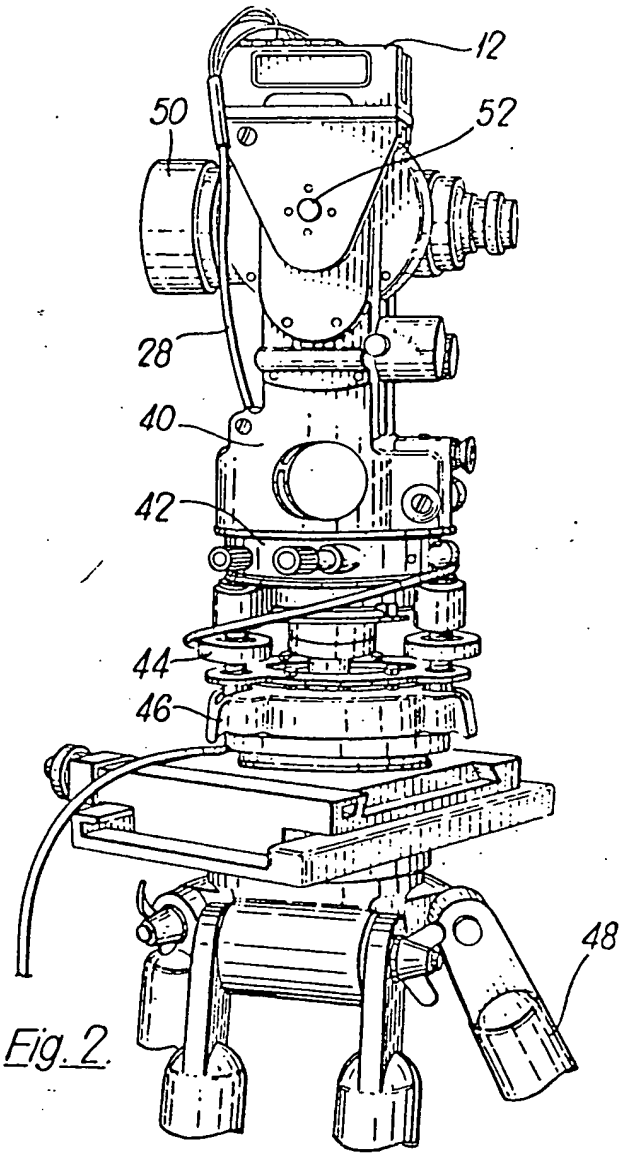

Fig. 2.

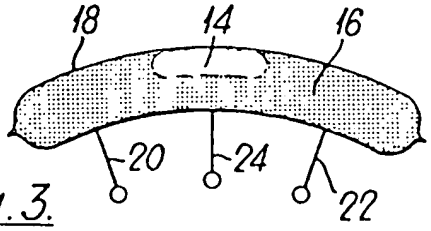

Fig. 3.

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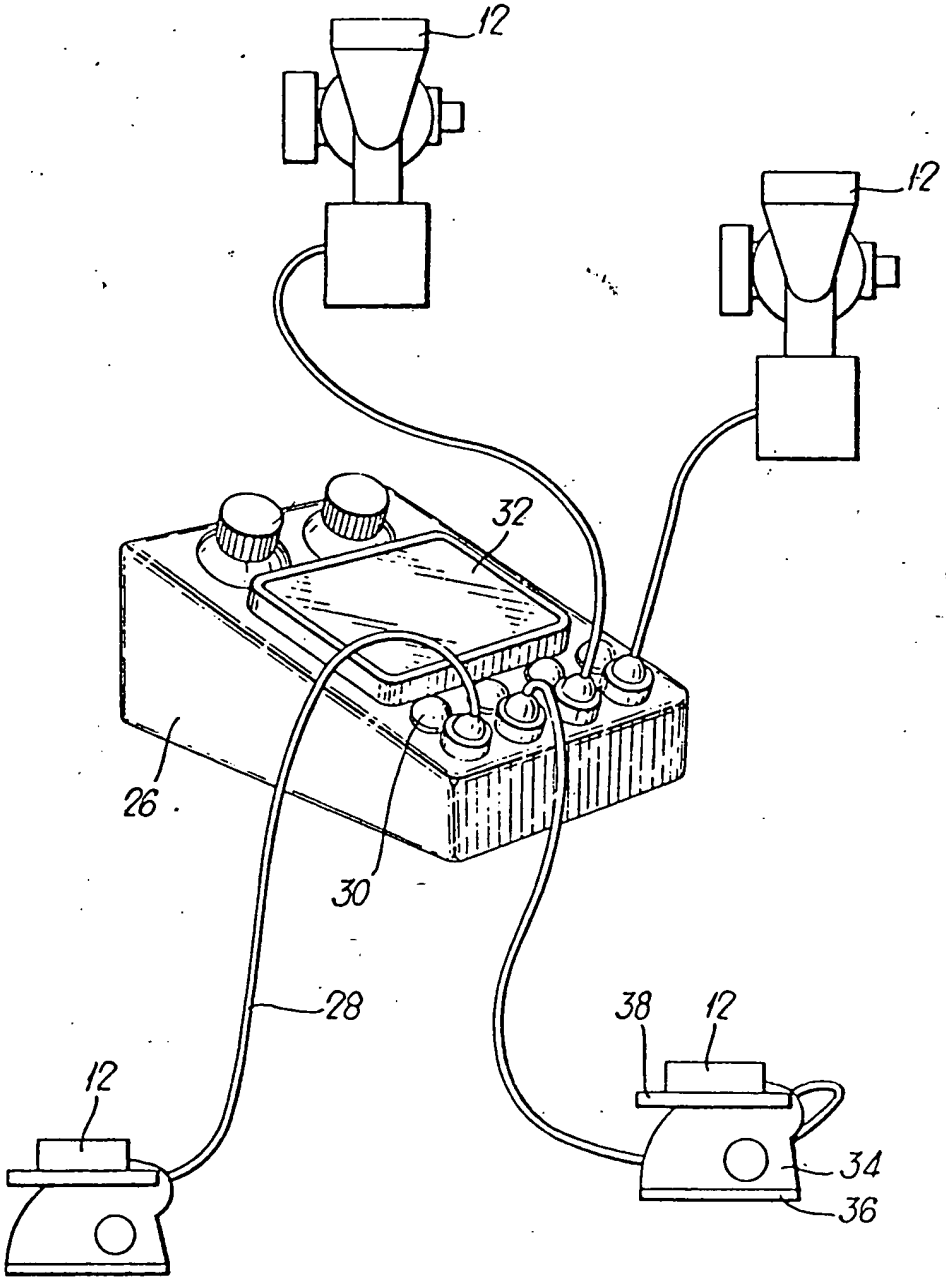

Fig. 1.